



# **Ozone Season Peak NO<sub>x</sub> Emissions and Flexibility in NO<sub>x</sub> Emissions from the PJM Power Pool**

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# Overview – context

## ***General problem***

- Ozone non-compliance in northeastern U.S.
- Ozone conducive conditions drive electricity demand

*(N.E. Ozone formation depends on NO<sub>x</sub> levels, temperature, & sun)*

## ***History and regulatory context***

*Persistent ozone non-compliance even given:*

1995-98: MACT - technology standards

1999-02: OTC “NO<sub>x</sub> Budget” cap-and-trade

2003+: NO<sub>x</sub> SIP Call - extend cap-and-trade,  
reduced cap



# Overview – description and solution?

## ***A detailed description:***

Use detailed CEMS data: \*describe peak emissions,  
\*effect of ozone season, \*operation of generating units.

## ***Suggests a solution??***

Could regulations target ozone episodes by reducing NO<sub>x</sub> emissions prior to forecasted episodes?

## **Possible costs of not knowing**

- Continued non-compliance
- Misused resources



# Data

*hourly historical data*

*EPA:*

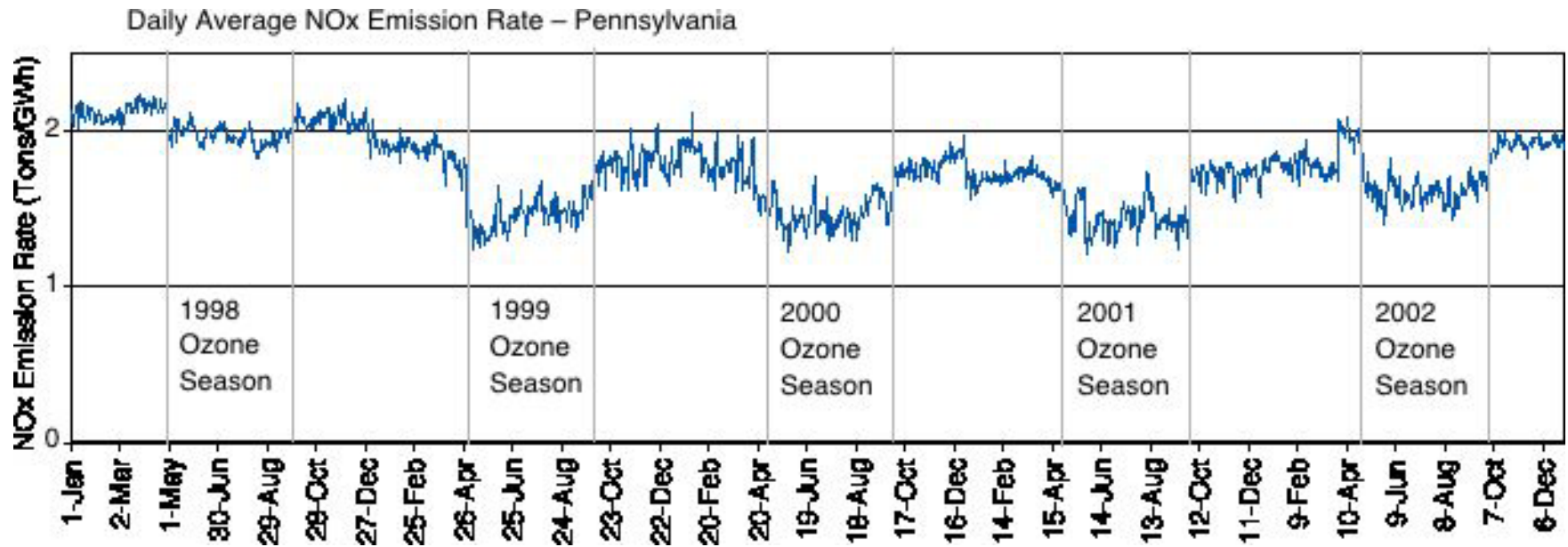
CEMS — Acid Rain Hourly Emissions Data

eGrid — emissions & Generation Resource Integrated Database

*Total electricity demand data from ISO websites*

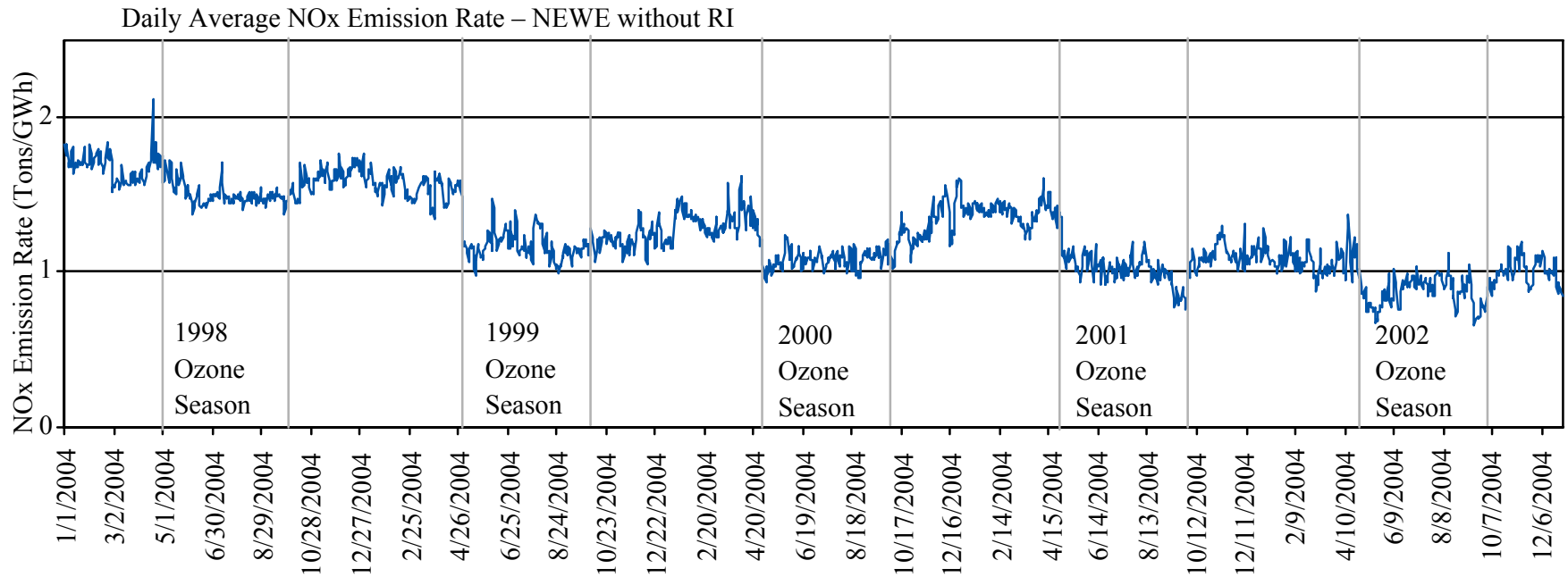


# NO<sub>x</sub> Trading in Ozone Season Reduces Summertime Emission Rates



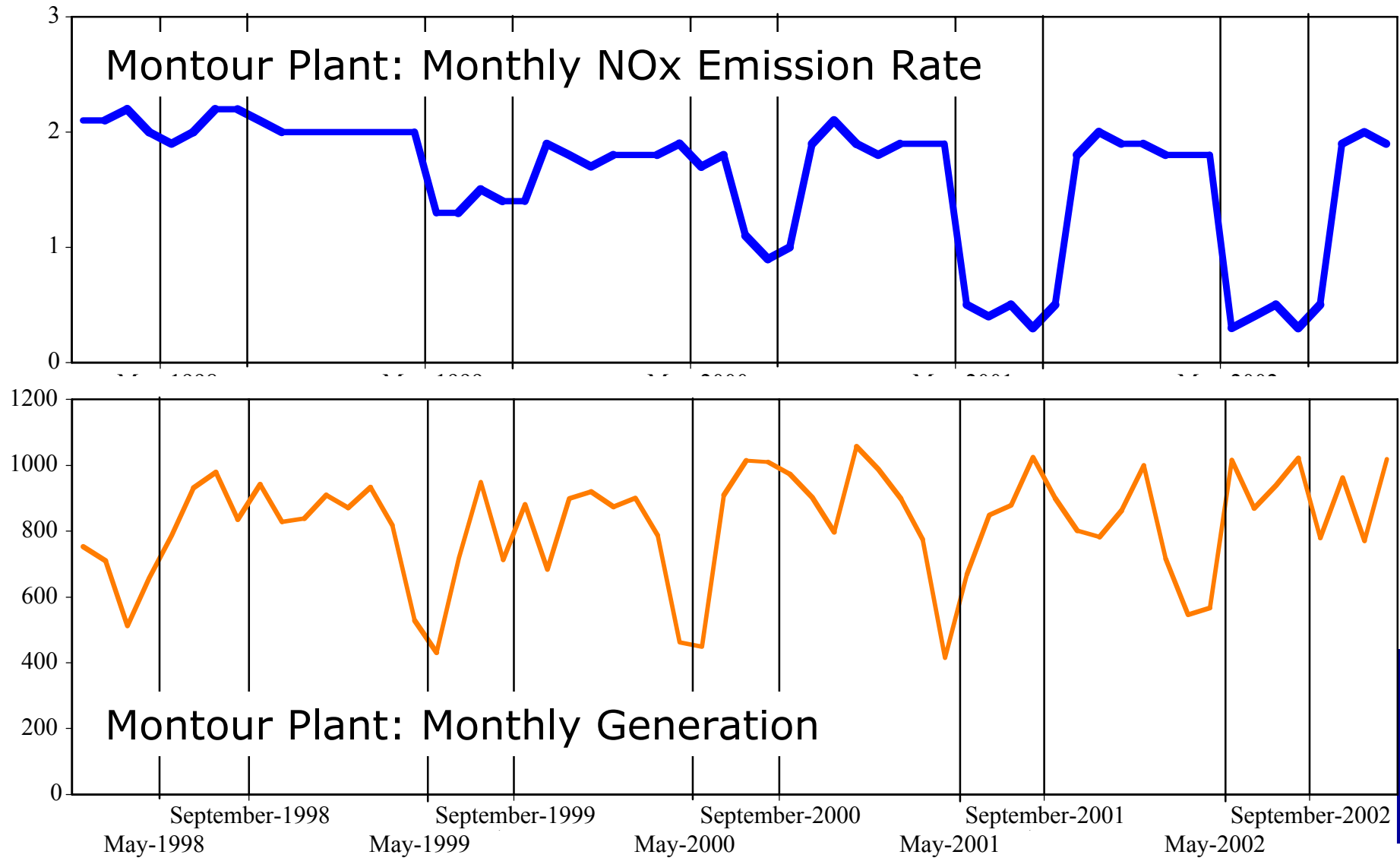


# NO<sub>x</sub> Trading in Ozone Season Reduces Summertime Emission Rates





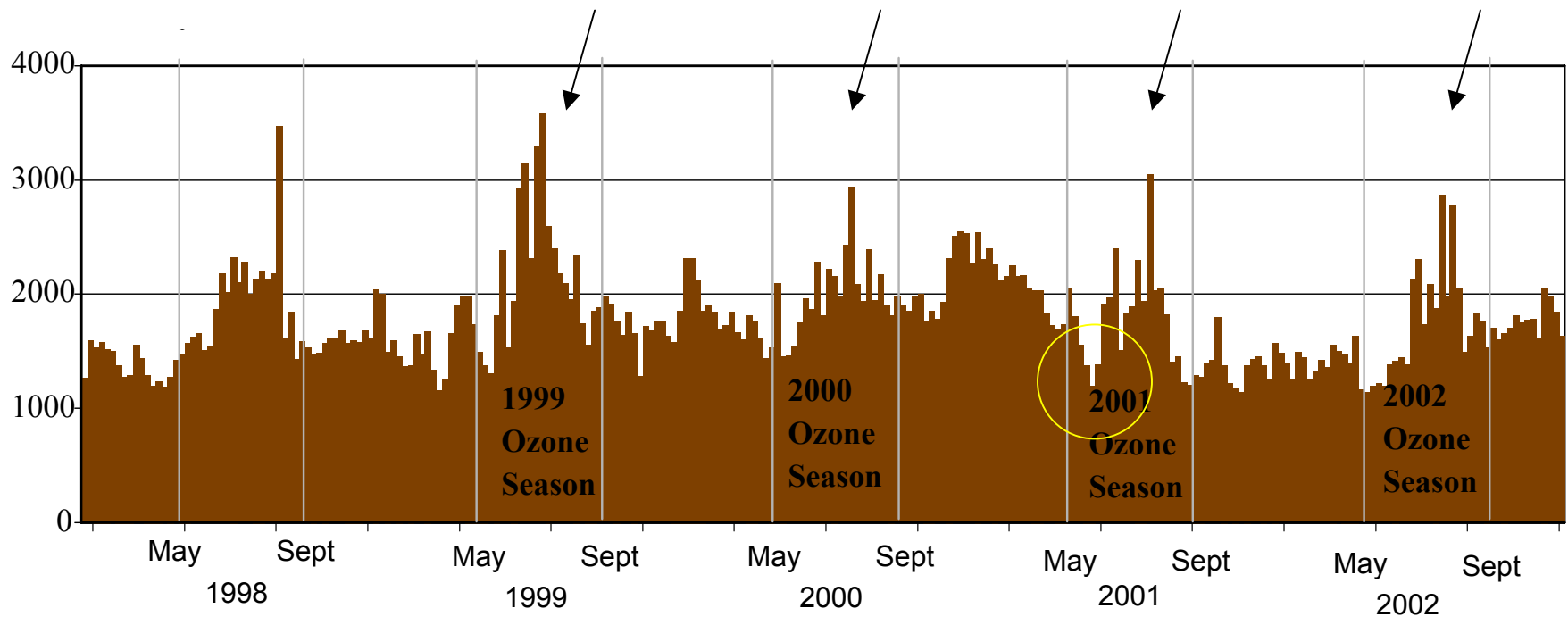
# Power plants use NO<sub>x</sub> controls in summer





# ...but peak emissions from power system not reduced much

Weekly NO<sub>x</sub> Emissions – New York Aggregate

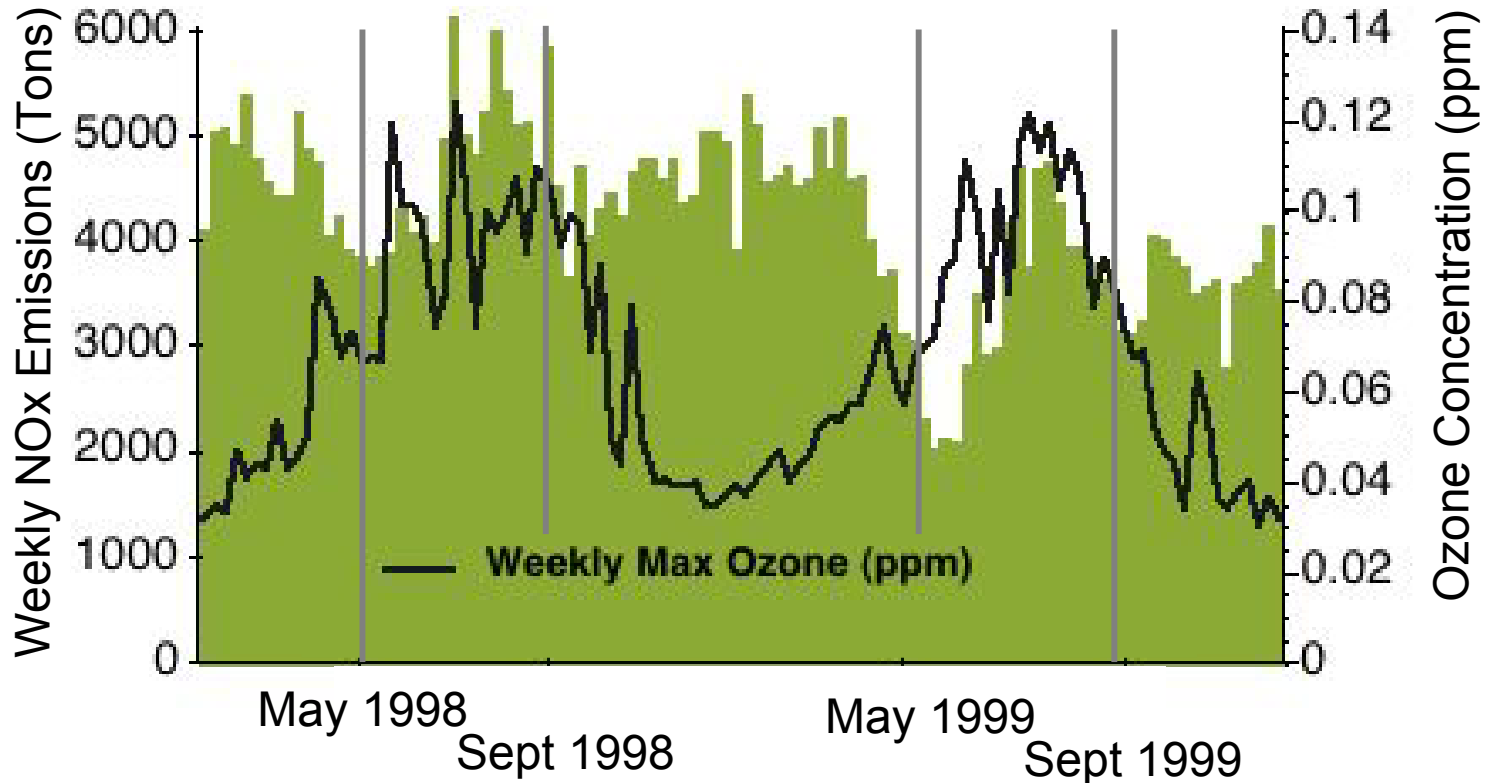






# Ozone concentrations and emissions

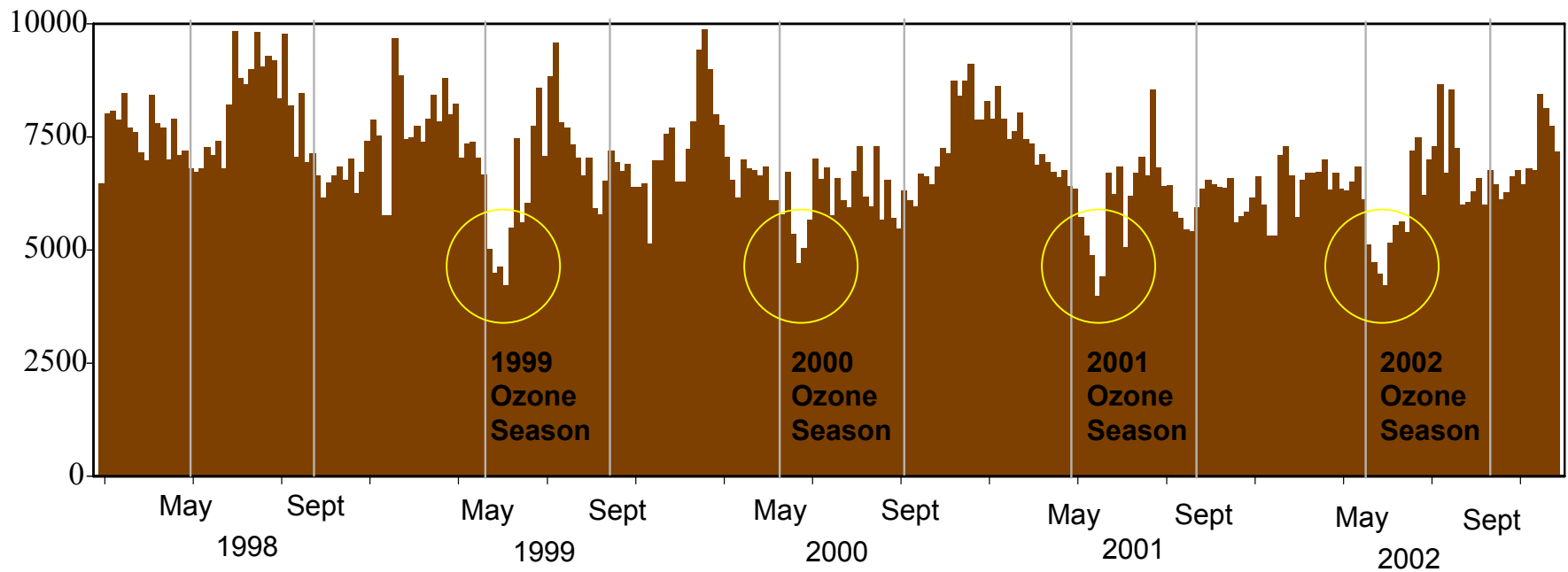
Weekly NO<sub>x</sub> Emissions and Ozone – PJM





# Compliance in early season

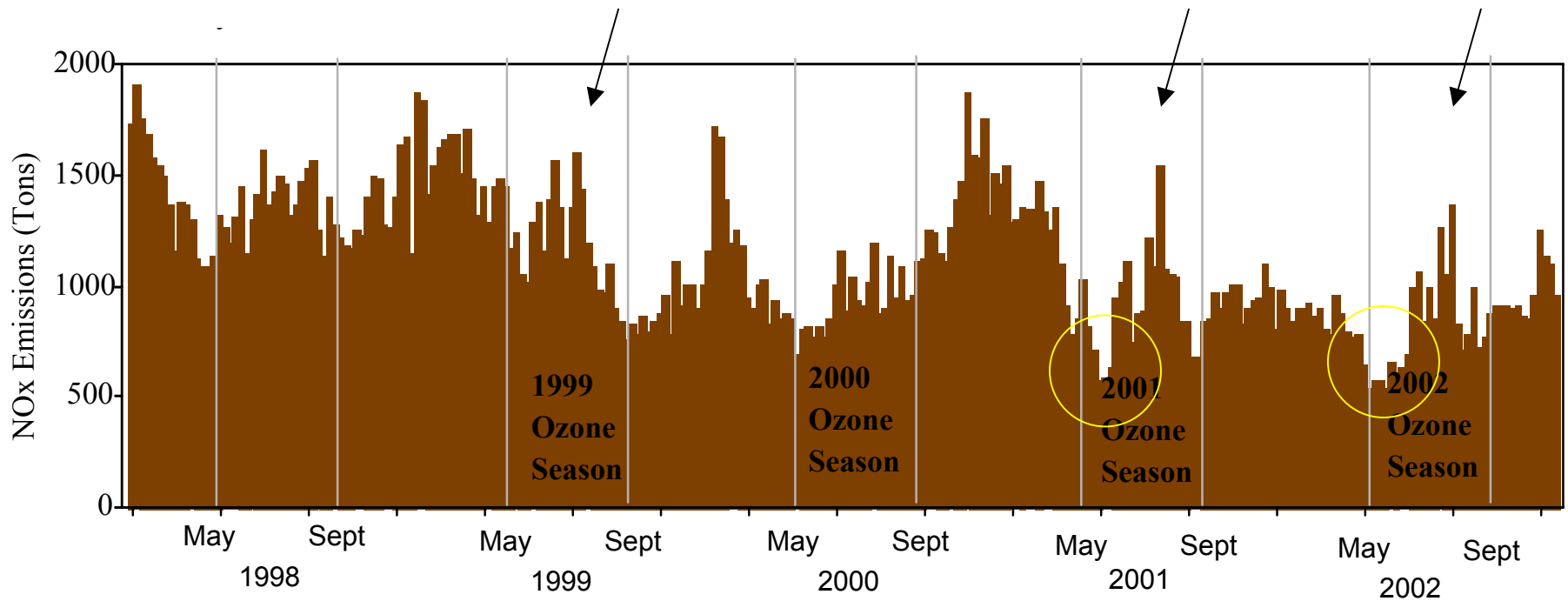
## Weekly NOx Emissions – PJM Aggregate





# Summertime peak electricity demand drives peak emissions

Weekly NO<sub>x</sub> Emissions – New England Aggregate



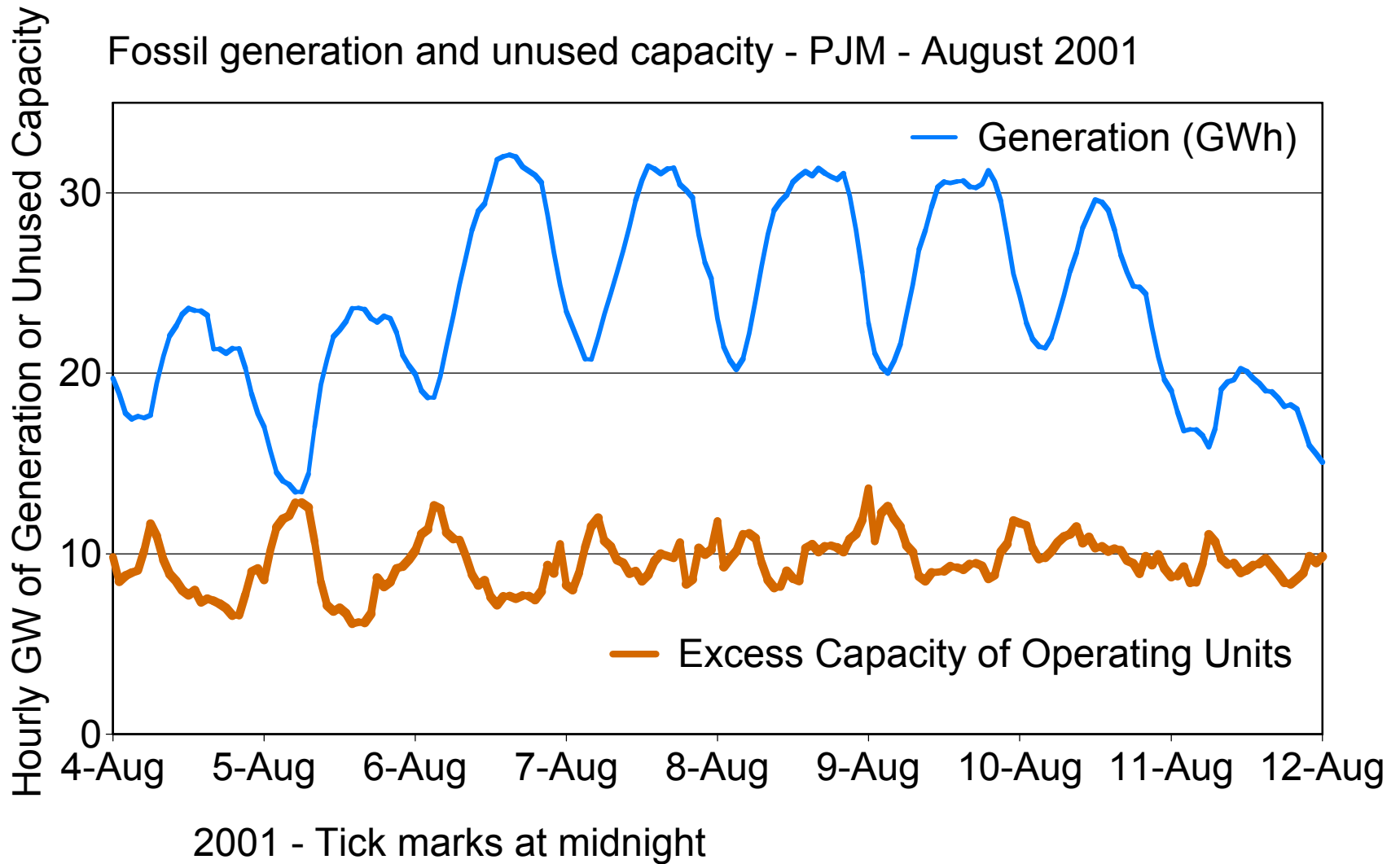


# A solution? “smart trading”

1. Could emission reductions on an hourly or daily basis reduce likelihood of ozone episodes?
  - Air shed modeling
2. Could regulations motivate the needed NO<sub>x</sub> reductions at critical times and in critical areas?
  - Flexibility in NO<sub>x</sub> emissions
  - Common perception: no flexibility on peak demand days



# Reserve capacity over time

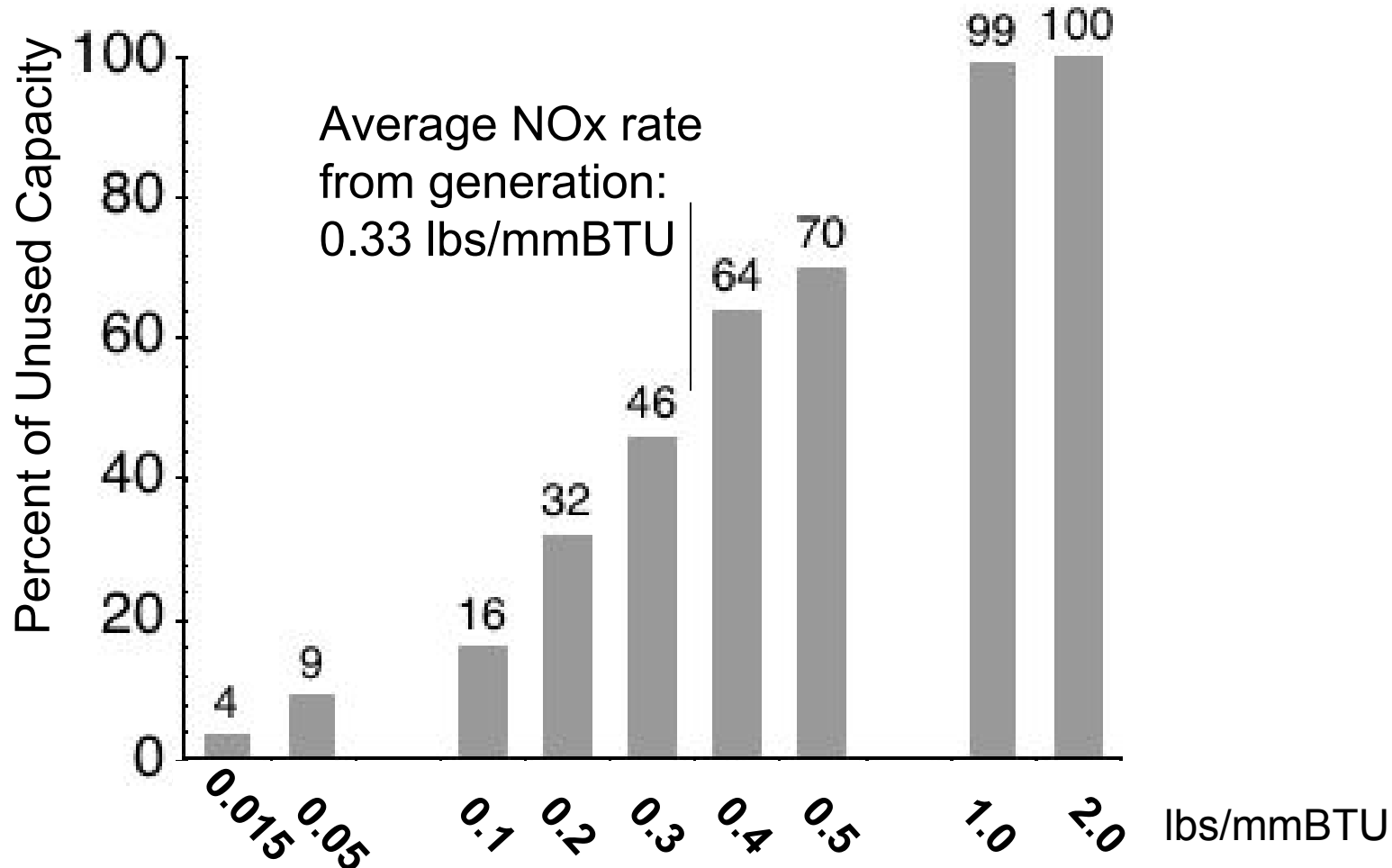




# NOx Rates of Unused & On Capacity

August 9, 2001 15:00

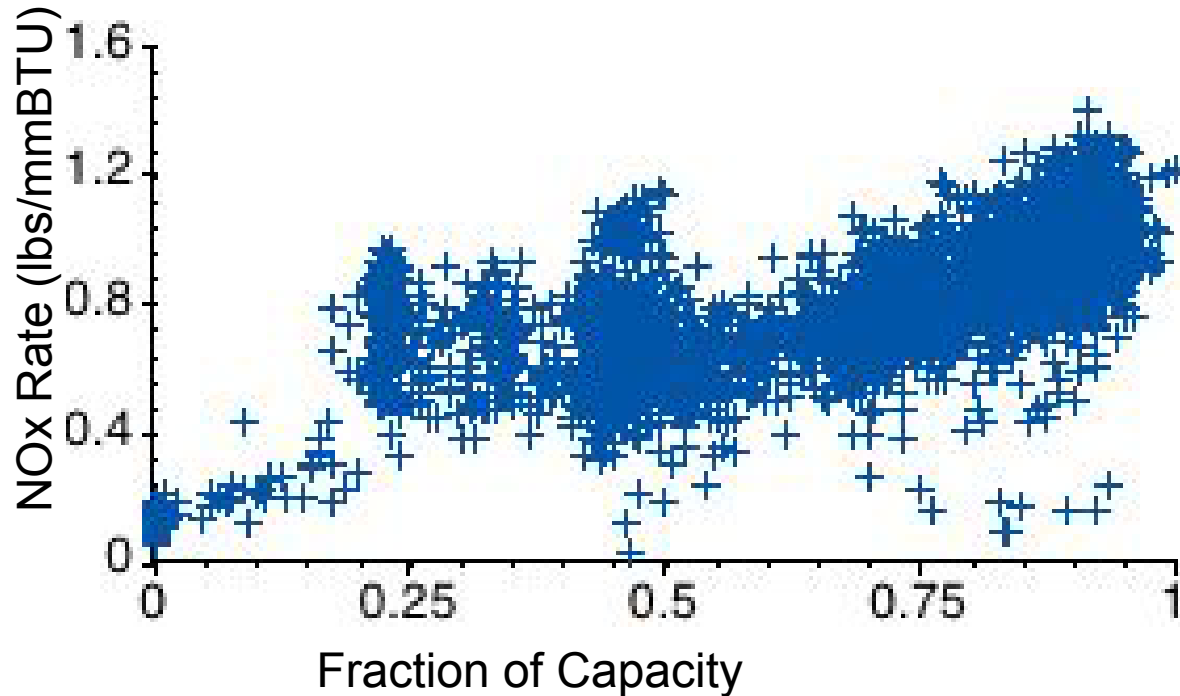
Percent of Unused Capacity with NOx Rate less than





# NOx Emissions versus Unit Load

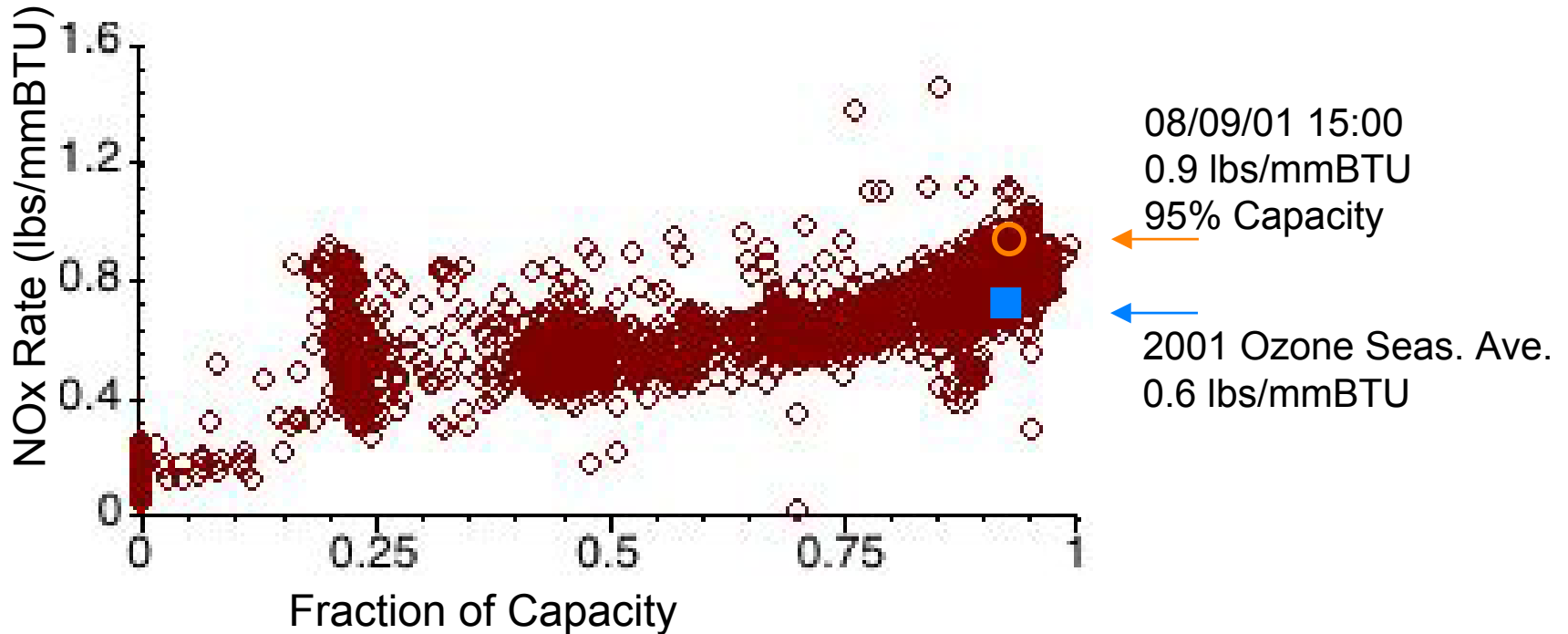
*Mercer, NJ 326 MW Coal – 2001 Winter*





# NO<sub>x</sub> Emissions versus Unit Load

*Mercer, NJ 326 MW Coal – 2001 Ozone Season*



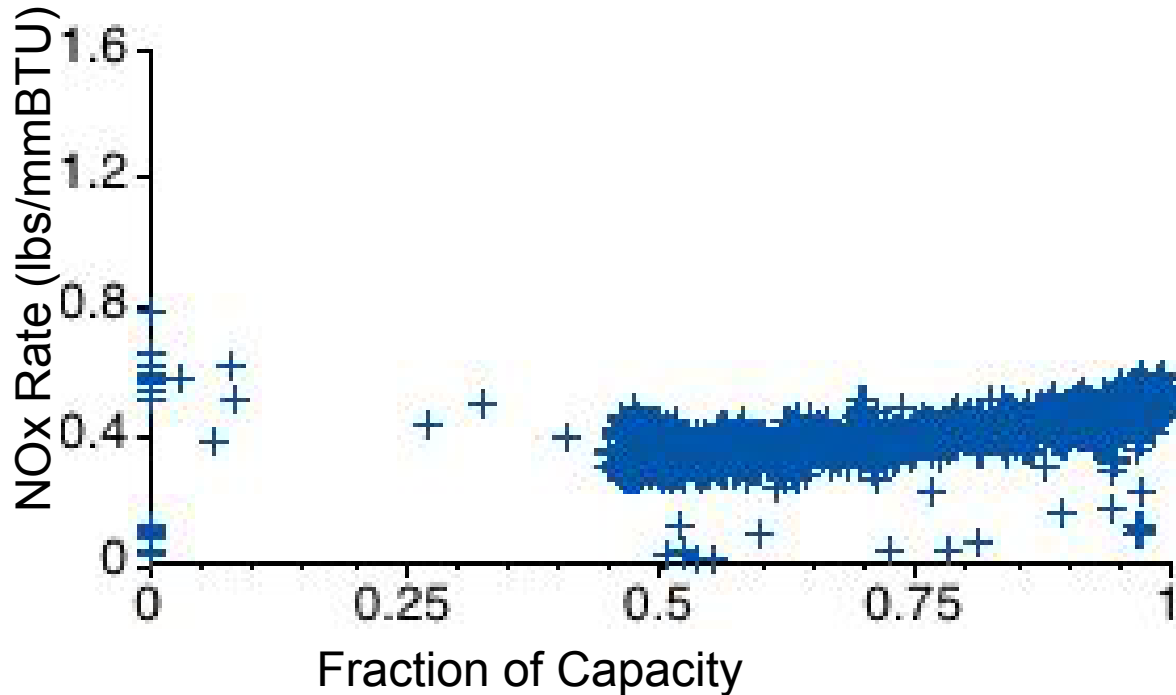
***Reduced from 95% to 20% in NO<sub>x</sub> dispatch case.***  
*Average emission rate may underestimate reductions.*





# NOx Emissions versus Unit Load

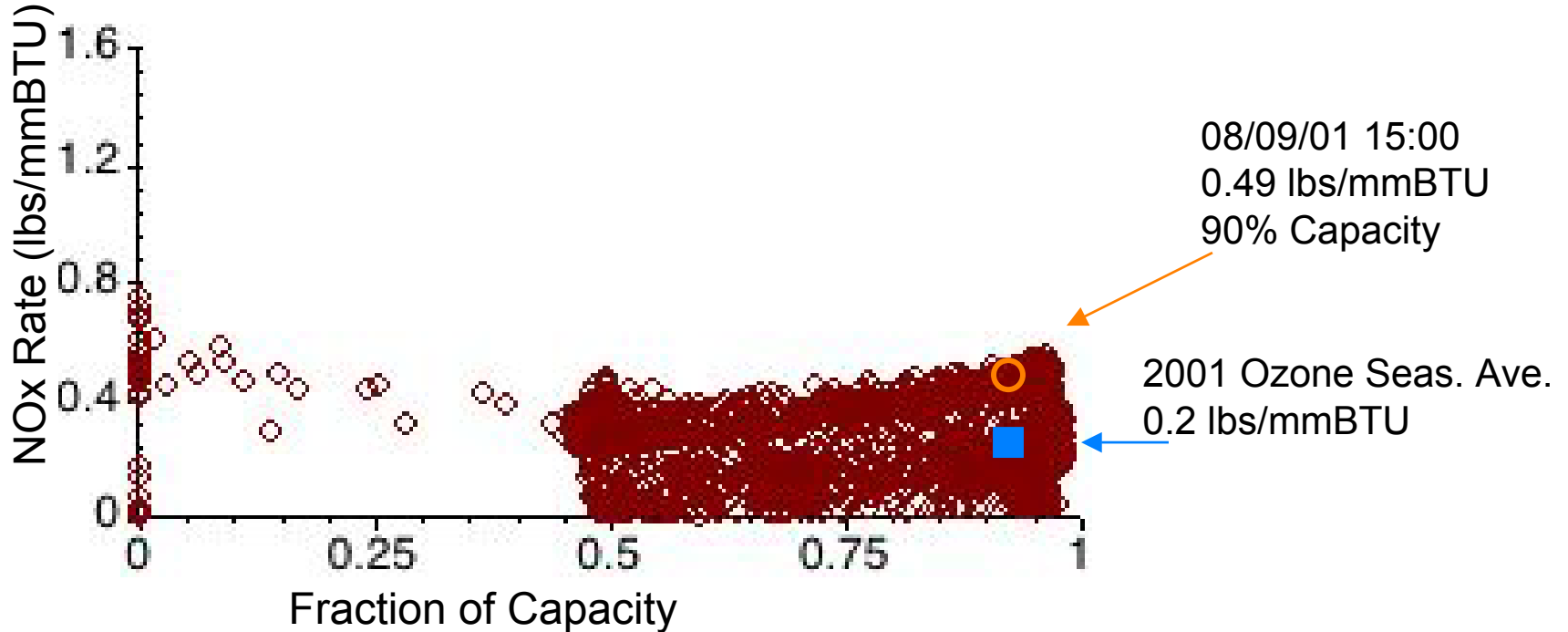
*Homer City, PA 733 MW Coal – 2001 Winter*





# NO<sub>x</sub> Emissions versus Unit Load

*Homer City, PA 733 MW Coal – 2001 Ozone Season*

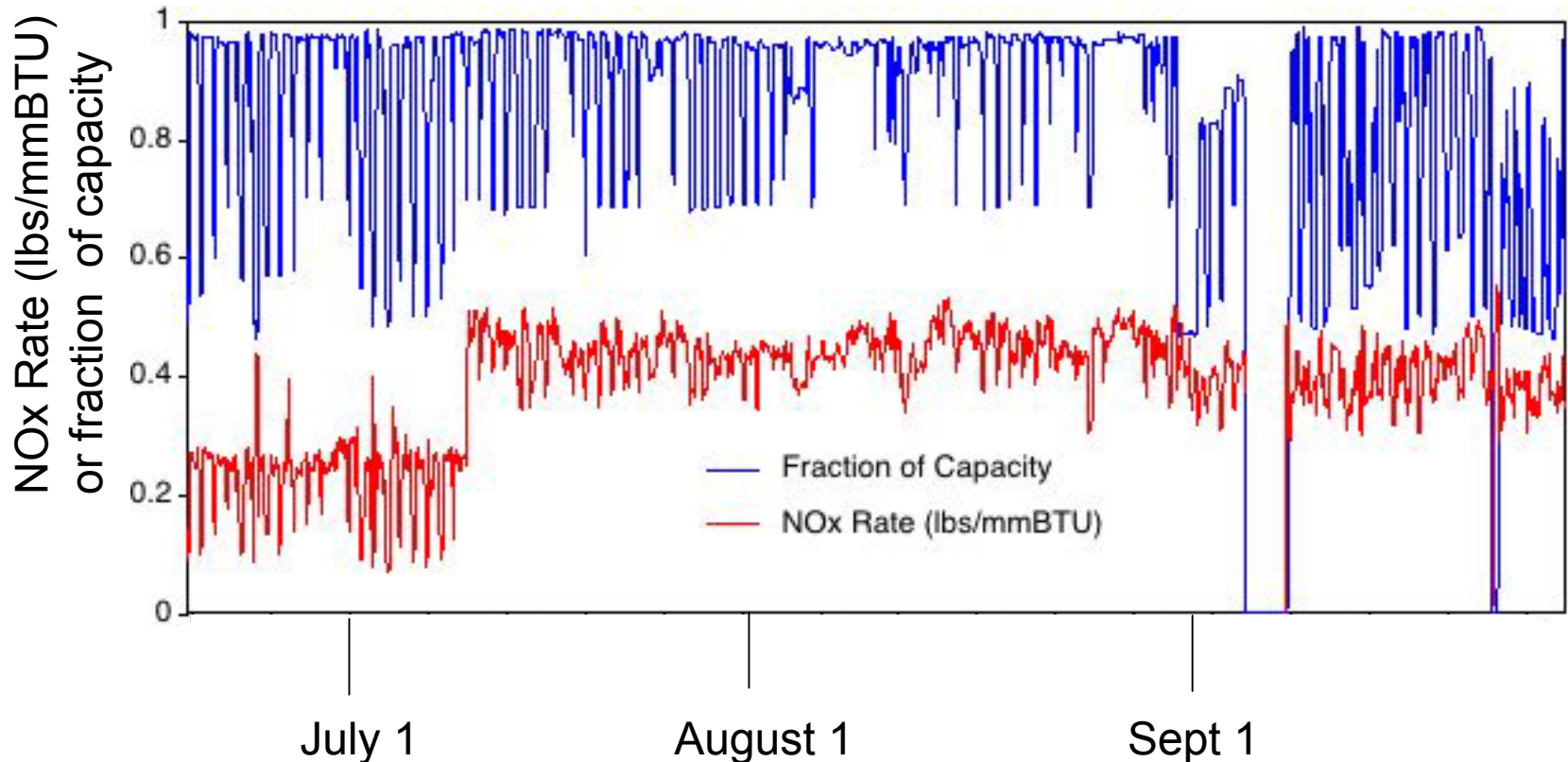


***Increased from 90% to 95% in NO<sub>x</sub> dispatch case.***  
*Average emission rate may not underestimate reductions.*



# NOx Emission rate time series

*Homer City, PA 733 MW Coal – 2001*



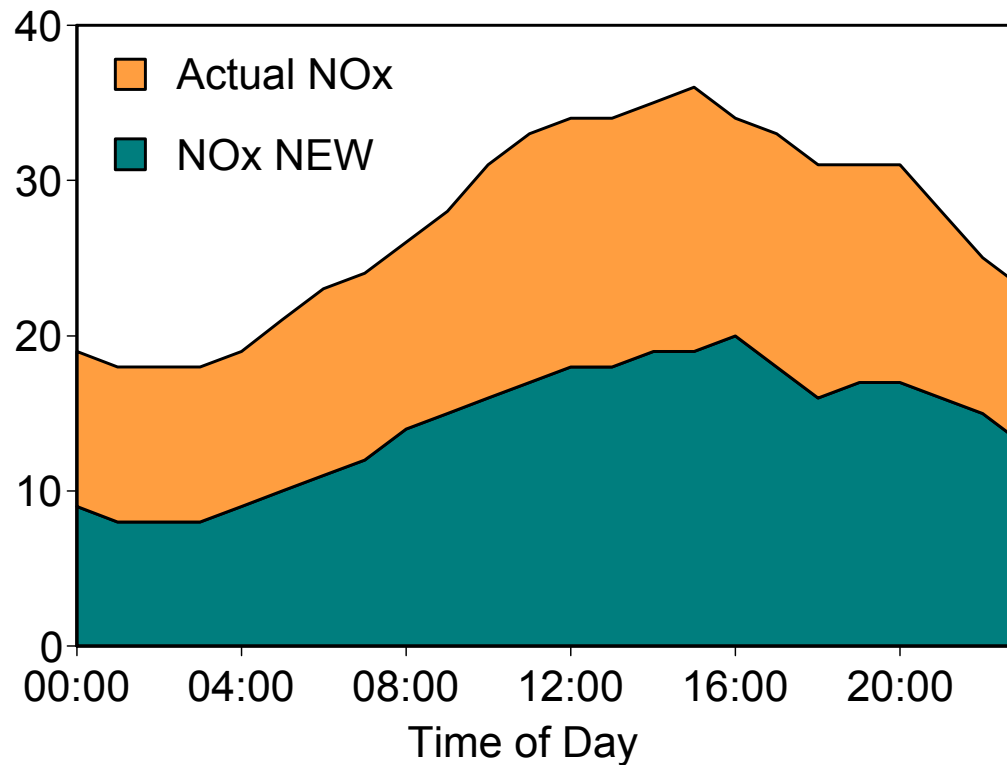
***Emission rate increases in mid-July***

*NOx prices fall from April 2001 to November 2001*



# Estimated NO<sub>x</sub> Reductions ~ 30% in each hour

*8/16/2001 NO<sub>x</sub> Emissions*





# Estimated NO<sub>x</sub> Reductions

Peak demand hour of 2001

*August 9 15:00*

<b>Demand</b>	<b>Fossil Gen.</b>	<b>Unused &amp; On Cap.</b>	<b>Total NO<sub>x</sub></b>
53.6	30.6	10.3	50.8
<i>(GWh)</i>	<i>(GWh)</i>	<i>(GWh)</i>	<i>(Tons)</i>

## Reduction in NO<sub>x</sub> (Tons)

<b>NO<sub>x</sub> Dispatch</b>	<b>By Fuel</b>	<b>By Area and Fuel</b>	<b>NG for Coal</b>
16.3	16.2	11.1	0.9
32%	32%	22%	2%



# Estimated NOx Reductions

	Demand	Fossil Gen.	Unused & On Cap.	Total NOx	NOx Reduced		By Area and Fuel	
<b>8/9/01 15:00</b>	53.6	30.6	10.3	50.8	16.3	32	11.1	22
7/17/01 6:00	33.5	21.4	10	28.7	10.8	38	4.4	15
7/17/01 15:00	46.8	28.2	8.8	35.8	10.6	30	6.3	18
8/13/01 17:00	42.1	23.3	8.1	33.6	10.4	31	5.3	16
6/15/01 18:00	40.3	26.2	8.4	31.2	9.9	32	5.2	17
6/15/01 6:00	35.0	22.7	10.7	24.4	8.0	33	3.4	14
	(GWh)	(GWh)	(GWh)	(Tons)	(Tons)	(%)	(Tons)	(%)



# Assumptions for flexibility estimates

- no impact from T&D constraints
- only used operating units
- units “turned down” to 20% or “up” to 95%
- average NOx emission rates (ozone season)
- use of control equipment unchanged



# Summary

***NOx Trading in ozone season reduced emissions – met cap, lowered rates***

***Peak summertime emissions still a problem for ozone***

***Unexpected flexibility in peak and other hours for short term reductions***

Further study: \*Which plants complied and how?  
\*Could “smart trading” help?





Thanks. Questions?

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